

3rd Generation, Statewide, Detailed Land Use Land Cover for New Jersey

Lawrence L. Thornton, Geographic Information Coordinator
Craig Coutros, Project Manager
John Tyrawski, Chief Scientist

Abstract

In 1984, the New Jersey Department of Environmental Protection (NJDEP) launched a pilot project to delineate the Land Use Land Cover (LULC) at 2.5 acre minimum map unit (MMU) using a 1984 orthophoto quadrangle. The project was expanded to map the entire state using 1986 hardcopy orthophoto-basemaps. In 1995 the statewide 1986 Land Use Land Cover was edited to statewide digital imagery using heads-up interpretation in ArcView and a 1 acre MMU.

The NJDEP has now completed the third iteration of the detailed LULC mapping to 81 classes (codes) Level I, II, III, IV of an edited version of Anderson et al. (1976), at a 1-acre MMU. Statistics can now be generated for any area of interest in the state for the trends in LULC from 1986-1995-2002. In addition the NJDEP contracted for the entire stream network of the state to be re-delineated to the 2002 imagery. The stream layer is currently being attributed and prepared for a geodatabase employing an NHD compliant ArcHydro data model. Results will be shared.

Patterns of Change in the Land Use Land Cover of New Jersey

Capturing changes in LU/LC from 1986 to 1995/97 to 2002 has built upon several database and mapping efforts of NJDEP over the last 16 years. The creation of 1986 orthophoto quads and quarter quads allowed the NJDEP to develop a digital LU/LC GIS dataset using a modified Anderson level II classification system. Subsequent digital imagery from 1991 allowed the NJDEP to conduct pilot studies on updating LU/LC using desktop ArcView GIS and heads-up digitizing techniques. The production of high resolution CIR imagery from 1995/97 gave the NJDEP the ability to perform a statewide evaluation of land use/land cover change. Finally, the latest production of 1-foot pixel resolution CIR imagery from 2002 gives the NJDEP the manuscript information necessary to perform a statewide delineation of watercourses and land use/land cover in more detail than ever before.

Beginning in 1995 and again in 2002, the contractor estimated for each land use polygon, the percentage of impervious surface in increments of 5%. These estimates have been shown to be very helpful in modeling, particularly surface water runoff.

Delineating change in LU/LC is a critical dataset that serves multiple interests internally in NJDEP and externally for other government agencies, the regulated community, non-government organizations, and citizens at large. This dataset will allow regulators, planners, and others interested in the trends of LU/LC over time to quantify those changes on GIS for any area of interest. No other single digital data layer is available which can be used for more diverse applications of monitoring the health of the citizens and ecosystems of New Jersey than a trend analysis of LU/LC.

Some of the NJDEP initiatives that will benefit immediately from this information include;

- Development of a Smart Growth model for the state.
- The Surface Water Quality Standards (SWQS) that establish the designated uses to be achieved and specify the water quality (criteria) necessary to protect the State's waters.
- The New Jersey Highlands Council and the implementation of the Regional Master Plan.
- National Environmental Performance Partnership Program (NEPPS) for assessing trends in environmental quality and for long term strategic planning.
- Enterprise Internet interactive mapping applications based on the landscape of New Jersey.
- Watershed planning and aquifer recharge mapping efforts by providing impervious surfacing information;
- Open-space acquisition opportunities by the evaluation of habitats in relationship to endangered species.
- Stream encroachment monitoring and land use regulation program

Results

New Jersey is the country's third smallest state with only about 4.8 million acres. As of 1986, 24% was urban/suburban, 21% wetland, 33% forest, 15% agriculture and 1% barren, with the remaining percentage open waters. By 1995, New Jersey had lost another 1% of agricultural lands, and 2% of forests, and gained 3% in urban/suburban lands. This may not sound alarming, but when freshwater wetlands, coastal wetlands, dedicated openspace, steep slopes and barren land are subtracted out, only non-dedicated agricultural lands and forests remain. These lands represent prime targets for development.

Between 1986 and 1995, the state lost almost 6% of available agricultural and forest lands, over 124,000 acres (Thornton et. al, 2001) to development. By 2003, it is estimated that over 11% of all forests and agriculture had been converted to urban or other pre-development classes since 1986. After deducting lands already preserved as open space, the figure is closer to 20% of all forest and agriculture (not already developed or held in trust). Factoring in competing uses, particularly the acquisition of additional dedicated openspace, Hasse and Lathrop (2001) (using the same NJDEP GIS data), estimated that the remaining available land would be developed in 40 years if current trends persist! Clearly the prime lands for development may soon be exhausted in New Jersey.

As of June 2006, the NJDEP has the 2002 LULC update for 60% of the state including all of central and northern New Jersey. These areas include 14 of the 20 Watershed Management Areas in the state.

The data show that the suburbanization of New Jersey continued with conversion of land cover to primarily urban/residential lands at the rate of 10,000 acres per year from 1995-2002, a slight dip of 8% compared to the years 1986-1995. Agricultural lands loss continued but also at a slightly lower (8%) rate. Most alarmingly the total acres per year of forests loss increased significantly in the 14 Watershed Management Areas completed to date some 2,700 acres/year from 1986-1995 to 1995-2002 (Table 1.0).



Figure 1. Gray area shows areas completed for 2002 LULC as of June 30, 2006

Other changes at Level 1 include an increase in Barren Lands, generally lands being prepared for some unknown activity at an increase of 300% (183 to 660 acres per year), and wetlands loss falling 20% 1628 to 1339 acres/year). Open waters showed a net loss compared to net gains in 1986 to 1995 but there are special circumstances for this change.

These statistics, both draft and incomplete, show a shift in development patterns in New Jersey. Agricultural lands, while still being consumed for other land uses are falling and more forested lands are being consumed. The reasons for this pattern are not known. Could there be fewer agricultural lands to choose from, or are development shifting from the flatlands of New Jersey to the forested rolling hills and highlands of New Jersey? More analysis will be required on the entire dataset.

<i>Land Use Type</i>	<i>1986</i>	<i>1995 REVISED (2002)</i>	<i>2002 UPDATE</i>	<i>Annual Rate of Change (9 years) 1986-1995 (ac/yr)</i>	<i>Annual Rate of Change (7 years) 1995-2002 (ac/yr)</i>
Agriculture	464,602	396,481	352,270	-7,569	-6,316
Barren Land	27,465	29,114	33,731	183	660
Forest	918,192	914,676	892,905	-391	-3,110
Water	182,335	188,019	187,532	631	-70
Urban Land	870,206	949,165	1,020,390	8,773	10,175
Wetlands	437,533	422,878	413,504	-1,628	-1,339
	2,900,333	2,900,332	2,900,332		

T

Table 1.0 Land Use Land Cover trends in New Jersey from 1986, 1995 to 2002 in total acres and in Annual Rate of Change in acres per year for Anderson Level 1 codes.

The NJDEP is heartened by the lower total rate of loss of wetlands but there are certainly improvements yet to be made. Since the tidal and freshwater wetlands are regulated in their entirety, the lower 1995-2002 rate represent some success in the regulation and enforcement of wetlands regulations. The further streamlining of ePermitting and the implementation of more restrictive development patterns by the Highlands Act will most likely reduce again the acres of wetlands lost in New Jersey in the next land use land cover assessment. Aggressive enforcement has also curbed losses and remanded violators to restore filled or altered wetlands.

Open water in New Jersey increased between 1986 and 1995 largely because of the addition of 2 new reservoirs. Net losses to these figures between 1995 and 2002 can be attributed in part to fill projects along the beach areas in central New Jersey and to tidal impacts on the interpretation of water. Depending on the time tide date of the photos, wetlands can either be open tidal waters or flats. As the delineations are completed statewide, it is expected that the net gain or loss total for water will be negligible.

The 2002 LULC data are critical for the modeling and implementation of Smart Growth in New Jersey. The NJDEP is committed to a Smart Growth model that preserves open space, farmland, and environmental resources. Understanding the current landscape of New Jersey through the 1986-1995-2002 detailed LULC coverage will lead to a thoughtful, well documented approach to the future of growth in a state that is the most densely populated state in the nation. The groundwork has been completed. It is up to the state agencies, working with the Governor's Office, to craft a plan that will serve the citizens of New Jersey in the 21st century.

Acknowledgements

The NJDEP acknowledges the hard work over the years of Aerial Information Systems of Redlands, CA for the interpretation and delineation of the land use land cover data for 1986, 1995 and 2002. Special thanks to Debbie Johnson, Lisa Cotterman, Tom, Ben, and the entire delineation staff.

The 2002 Land Use Land Cover and Hydro delineations were funded by the New Jersey Department of Transportation, the National Oceanic and Atmospheric Administration (NOAA) and the NJDEP.

End Notes

For more information and graphic maps, go to the following site for the 2006 26th Annual ESRI International User Conference presentation on this topic and scroll down to Papers and Presentations by BGIS: <http://www.nj.gov/dep/gis/linksnew.html#miscell>

Much of the GIS (shapefile) data used in the compilation of this paper can be downloaded for the New Jersey Department of Environmental Protection, Bureau of GIS website at: <http://www.nj.gov/dep/gis/>

References

Anderson et al., 1976, **A Land Use and Land Cover Classification for Use with Remote Sensor Data**, Geological Survey Professional Paper 964, Wash., D.C.

Environmental Systems Research Institute (ESRI), 1995, **Metadata Document for the New Jersey Department of Environmental Protection's Geographic Information System Environmental Database, Integrated Terrain Unit Mapping**. Redlands, CA, 90p.

NJDEP, 2006, **Mapping and Digital Data Standards**.

NJDEP, 1993, **A Method for Evaluating Ground Water Recharge Areas in New Jersey**, NJGS Report GSR-32, 95p.

USDA, Soil Conservation Service, **Urban Hydrology for Small Watersheds**, Technical Release 55, 1986.

Author Information

Lawrence L. Thornton, MS, Geographic Information Coordinator
New Jersey Department of Environmental Protection
Office of Information Resources Management
Bureau of Geographic Information Systems
(609) 633-8144 (voice) (609) 984-7900 (FAX)

Lawrence.thornton@dep.state.nj.us

Craig Coutros, Project Manager
New Jersey Department of Environmental Protection
Office of Information Resources Management
Bureau of Geographic Information Systems
(609) 292-0899 (voice) (609) 984-7900 (FAX)
Craig.coutros@dep.state.nj.us

John Tyrawski, MS, Chief Scientist
New Jersey Department of Environmental Protection
Office of Information Resources Management
Bureau of Geographic Information Systems
(609) 777-0151 (voice) (609) 984-7900 (FAX)
John.tyrawski@dep.state.nj.us